Determining the Water Bootprint of the Army's Supply Chain

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Report Documentation Page

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What is a Water Bootprint?

- The water bootprint (footprint) is an indicator of water use
- Direct (operational) water refers to the water used in support of daily operations e.g. drinking, washing vehicles, watering lawns, etc.
- Indirect (supply chain) water use refers to water that is “embedded” in the energy, materials, and other products the Army procures
- The water footprint is the volume of water used to produce one unit or piece

Water Bootprint Components

- There are three primary components of a water bootprint
  - ***Blue water***
  - ***Green water***
  - ***Grey water***
- Depending on the processes, blue and green water that is not consumed will become grey water.

Water Bootprint of a Product

- Water bootprint of a product is the sum of the water footprints of all the process steps
- Coca-Cola determined the water footprint of its 0.5 liter bottle of Coca-Cola –
  - Product Packaging
  - Product Ingredients
  - Plant Operations
- Study concluded that approximately 35 liters of water are used to produce a single 0.5 liter bottle of soda

Study Objective

- Quantify how much water is needed to produce the goods and services the Army obtains
- Identify related sustainability issues and policy implications
- This enables the Army to render proactive supply-side policy decisions

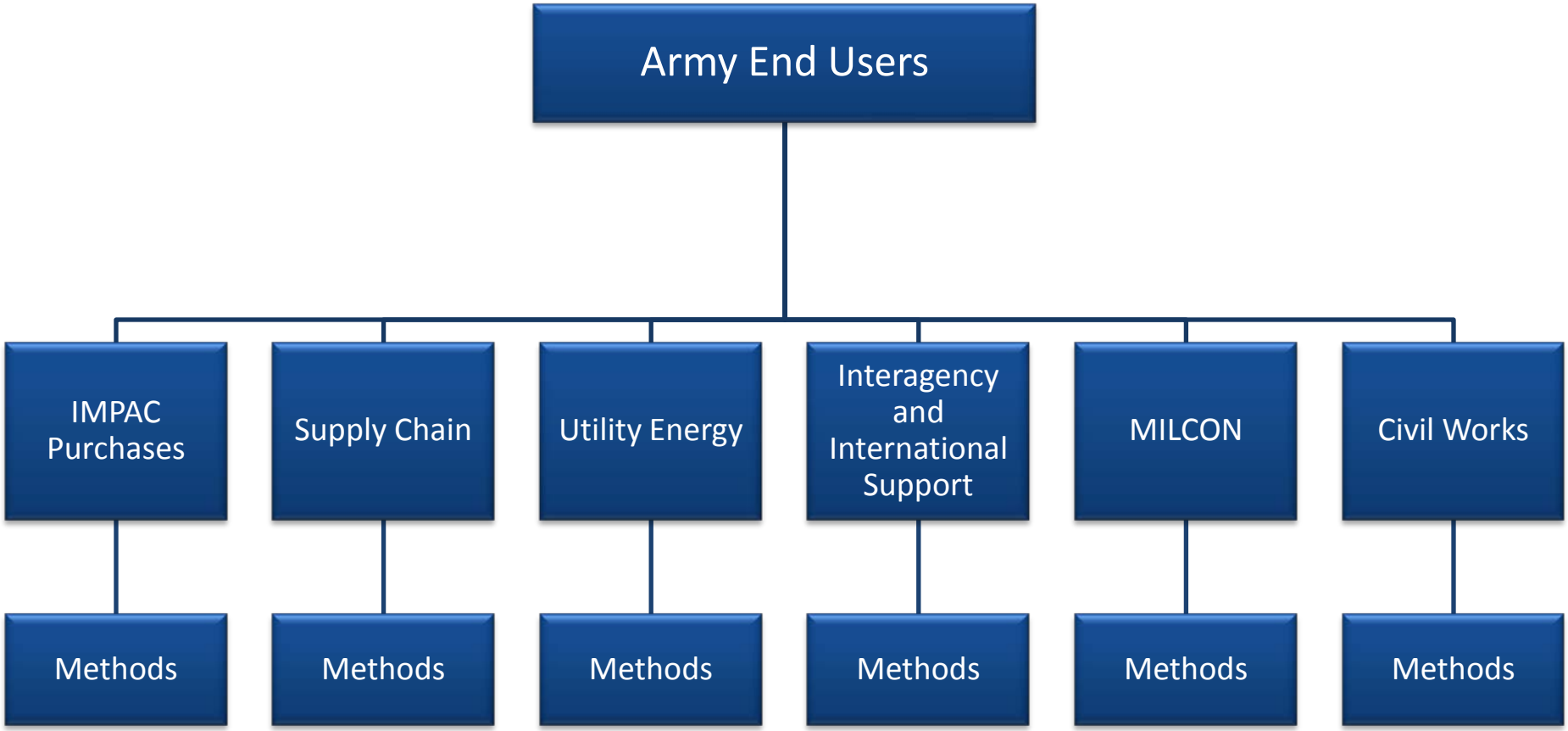
Methods

- Identify Supply Chain/Commodities
- Identify Key suppliers
- Develop a water factor for each commodity
- Learn the usage of each commodity

- Assumptions
  - Skip direct water usage (on-installation utilities)
  - Water factors and Procurement data are available numbers

Water Factor Calculation Alternatives

- Obtain water use data directly from all producers/suppliers
- Develop water use factors from the literature
- Apply economic activity levels to Life Cycle Assessment (LCA) model outputs by sector use Use the ECO –LCA Model


Army End Users
IMPAC Purchases
Supply Chain
Utility Energy
Interagency and International Support
MILCON
Civil Works
Methods
Methods
Methods
Methods
Methods
Methods

IMPAC Bootprint Calculation Steps

- Determine total amount Army spent in FY10 on IMPAC transactions from DoD GSA Smart Pay data
- Align to appropriate Eco-LCA model economic market sector (sector = retail trade)
- Adjust expenditures to 1997 economy using CPI conversion factor (for retail trade = 0.811)
- Multiply adjusted expenditures by retail trade water use factor per $1M (= 7,536,079 gallons) to determine total water bootprint

Army End Users

US Army Government Purchase Card Program
Army GPC Statistics – FY10 through 30 June 2010

Merchant Group	Total Spend
Wholesale Trade	$1,020,772,923
Business Expense	$588,842,074
Other	$290,688,096
Office Services	$267,531,165
Building Services	$161,460,031
Office Supplies	$77,918,039
Hotels	$76,548,798
Mail/Telephone	$71,432,848
Medical	$65,971,891
MRO Supplies	$64,237,331
Vehicle Expense	$49,725,698
Eating/Drinking	$42,625,626
Other Travel	$21,123,509
Money	$16,689,932
Auto/RV Dealers	$11,431,725
Rental Cars	$5,654,685
Landscaping and Horticultural Services	$4,330,949
Retail Services	$2,318,210
Veterinary Services	$1,509,487
Agricultural Cooperative	$551,528
Airline	$525,937
Grand Total as of 30 June 2010	**$2,841,890,482**

Civil Works & MILCON Bootprint Calculation Steps

- Obtain from HQ, USACE total amount spent in FY10 on Civil Works & MILCON construction
- Align various construction categories to appropriate Eco-LCA model economic market sectors
- Adjust expenditures to 1997 economy using CPI conversion factors
- Multiply adjusted expenditures in each construction category by applicable water use factor/$1M to determine total water bootprint

Army End Users

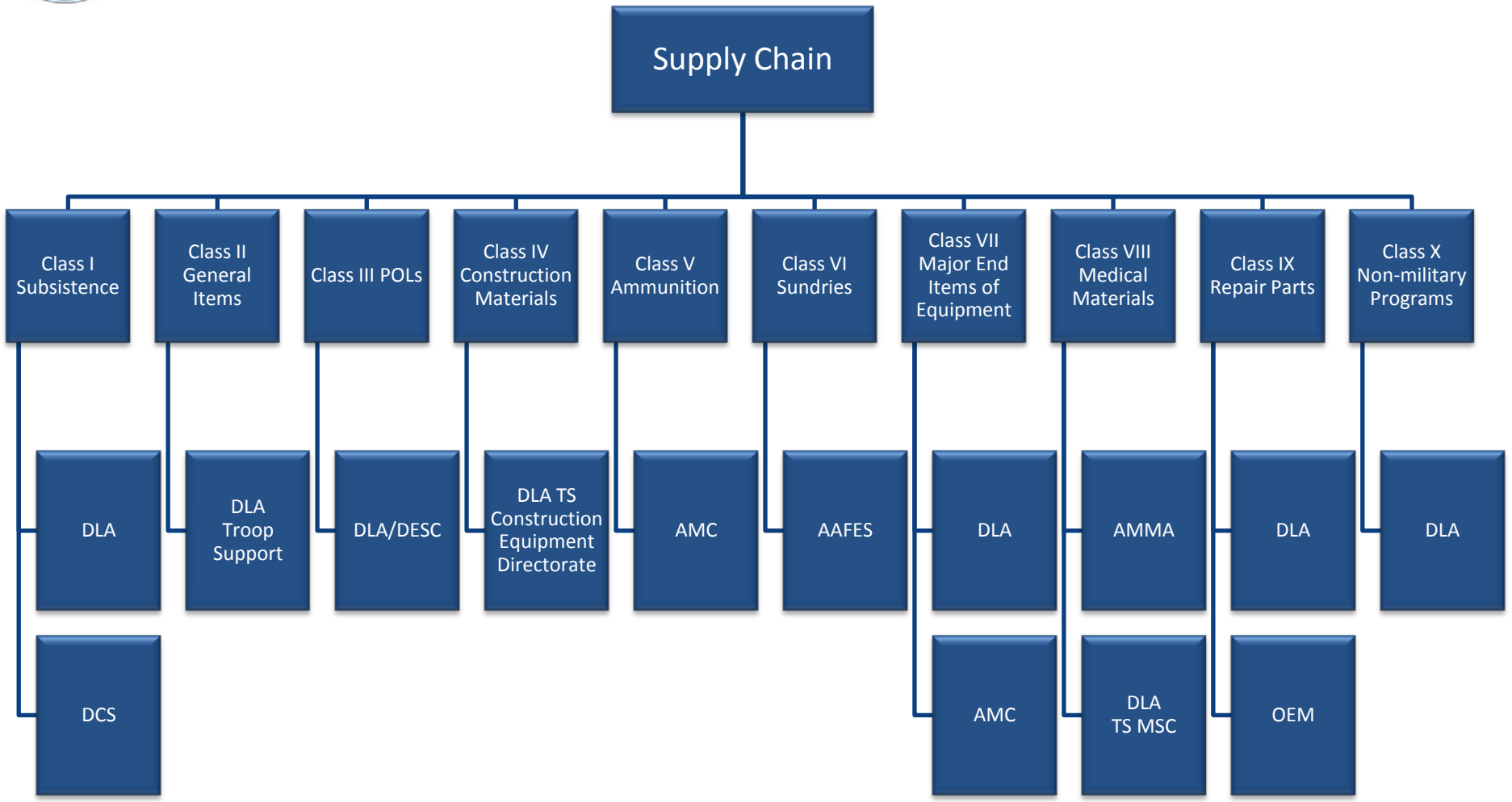
Civil Works

Program Component	FY10 Funded ($M)	FY11 Request ($M)
Construction	$ 2,028	$1,690
Operation and Maintenance	$ 2,400	$2,361
Investigations	$ 162	$ 104
Mississippi River and Tributaries	$ 340	$ 182
Flood Control and Coastal Emergencies	$ 0	$ 30
Regulatory Program	$ 190	$ 193
Expenses	$ 185	$ 185
Office of the Assistant Secretary (Civil Works)	$ 5	$ 6
Formerly Utilized Sites Remedial Action Program	$ 134	$ 130
Totals	$5,446	$4,881

Source: FedSources Analysis, 15 Nov 2010, based on OMB FY11 Budget of the US Government, 1 Feb 2010.

Civil Works Bootprint Calculation

Civil Works/MILCON Component	FY10 Funded ($M)	CPI Conversion Factor[a]	FY10 Expenditures ($M) (Adjusted)	Water Use (L/$1M)	Water Use (Gal/$1M)	Total Water Use (Gal)
Construction[b]	$ 2,028	0.74	$1,501	18,378,103	4,854,981	7,287,326,913
Operation and Maintenance[b]	$ 2,400	0.74	$1,776	18,378,103	4,854,981	8,622,446,767
Investigations[c]	$ 162	0.74	$ 120	10,728,093	2,834,062	340,087,467
Mississippi River & Tributaries[d]	$ 340	0.74	$ 252	20,769,003	5,486,590	1,382,620,686
Regulatory Program[e]	$ 190	0.74	$ 141	38,689,146	10,220,591	1,441,103,328
Expenses[b]	$ 185	0.74	$ 137	18,378,103	4,854,981	665,132,436
Office of the ASA(CW)[f]	$ 5	0.74	$ 4	9,469,558	2,501,593	10,006,370
FUSRAP[g]	$ 134	0.74	$ 99	43,738,844	11,554,580	1,143,903,426
MILCON[b]	$7,000	0.74	$5,180	18,378,103	4,854,981	25,148,803,071
TOTALS	**$12,446**	**N/A**	**$9,210**	**N/A**	**N/A**	**46,041,430,464**
Water Bootprint (Gal)	**46,041,430,464**	Or 69,759,743 Olympic sized swimming pools				



Army End Users

Supply Chain Components

- The supply chain primarily consists of the ten categories (classes) of products and services the Army routinely procures through the supporting supply system, and purchased energy, which are briefly described as follows:
  - *Class I* – Subsistence (food) and gratuitous health and welfare items
  - *Class II* - Clothing, individual equipment, tentage, tool sets and tool kits, hand tools, and administrative and housekeeping supplies and equipment.
  - *Class III* - Petroleum, oils, and lubricants: petroleum fuels, lubricants, hydraulic and insulating oils, preservatives, liquid and compressed gases, chemical products, coolants, deicing and antifreeze compounds, together with components and additives of such products, and coal.
  - *Class IV* - Construction materials to include installed equipment and all fortification and barrier materials.
  - *Class V* – Ammunition and explosives
  - *Class VI* - Personal demand items (nonmilitary sales items) - these items are procured through the Army and Air Force Exchange Service (AAFES)
  - *Class VII* - Major end items – a final combination of end products which is ready for its intended use and principal items (for example, launchers, tanks, mobile machine shops, and vehicles)
  - *Class IX* - Repair parts.
  - *Class X* - Materiel to support nonmilitary programs (for example, agriculture and economic development) not included in Class I through IX. Many Class X items are nonstandard items (windmill parts, kits, and plows, for example)

LMARS Data

- Logistics Metric Analysis Reporting System (LMARS) maintains the logistics pipeline information for all wholesale items
- Data pulled for FYs 2002 – 2010 used only closed procurement requests to represent material actually being purchased

FY	Total Amount	# of Records
2002	$8,673,399,476.11	252,171
2003	$9,792,416,350.89	252,313
2004	$11,026,673,033.22	275,041
2005	$12,237,547,927.88	274,204
2006	$12,691,574,514.12	258,066
2007	$13,016,250,306.43	256,032
2008	$12,890,383,149.95	256,038
2009	$11,805,196,188.17	255,922
2010	$18,946,912,972.27	246,492
Total	$111,080,353,919.05	2,326,279

Supply Class VI
Bootprint Calculation Example

Parameter	AAFES Sales Category/Eco-LCA Model Market Sector			
	Gas/Petroleum Refining	Retail Less Gas/Retail Trade	Food & Beverages/ Food & Drinking Places	Concession/Personal Care Services
CY10 Retail Sales	$ 748,472,049	$ 2,840,155,885	$ 412,800,332	$ 582,446,030
CPI Conversion Factor	0.425[a]	0.811[b]	0.723[c]	0.793[d]
CY10 Retail Sales (Adj)	$ 318,100,621	$ 2,303,366,423	$ 298,454,640	$ 461,879,702
Water Use (L/$1M)	44,136,271	28,527,162	107,741,112	26,431,605
Water Use (Gal/$1M)	11,659,569	7,536,079	28,462,191	6,982,491
Total Water Use (Gal)	3,708,909,026	17,358,347,953	8,494,683,147	3,225,073,088
Water Bootprint (Gal)	**32,787,013,214**	Or 49,677,293 Olympic Sized Swimming pools worth of water		

Using the Data – Case Studies

- Abrams tank (M1, M1A1, M1A2)
- 1993 estimated cost per unit $4.3 million
- 8,800 made total from 1980 to 1993.
- There are 11 major suppliers of the Abrams. Final assembly at Lima, Ohio, a GOCO, where other components are made such as the turret.
- Note three* are located in desert environments
- 634 Trillion gallons or
- 72 million gallons/tank

1. *Ashot Ashkelon, Israel- Drive Train, Suspension and Mobility solutions for Tanks & APC's; Tungsten Based Armor Penetrators and Fragments Manufacture
2. ATI Electronique, France - Military Interconnect Products
3. BEI Precision Systems & Space Company, AR - Optical Encoders, Scanners and Accelerometers
4. Bose Corporation, MA - Bose® Military Headsets
5. Cobham Defence Communications, UK - Platform Communication Systems
6. Data Device Corporation, NY - High-Reliability Data Networking Technology
7. Diehl Remscheid Germany- Armoured Vehicle Tracks
8. *Esterline Defense Technologies CA- Combustible Ordnance Products for Military Applications
9. ISO Group FL - Spare Parts, Components and Logistics
10. Kidde Aerospace & Defense NC - Automatic Fire Extinguishing Systems
11. *Parvus Corp UT- Rugged COTS Embedded Computer and Network

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Back-up Slides

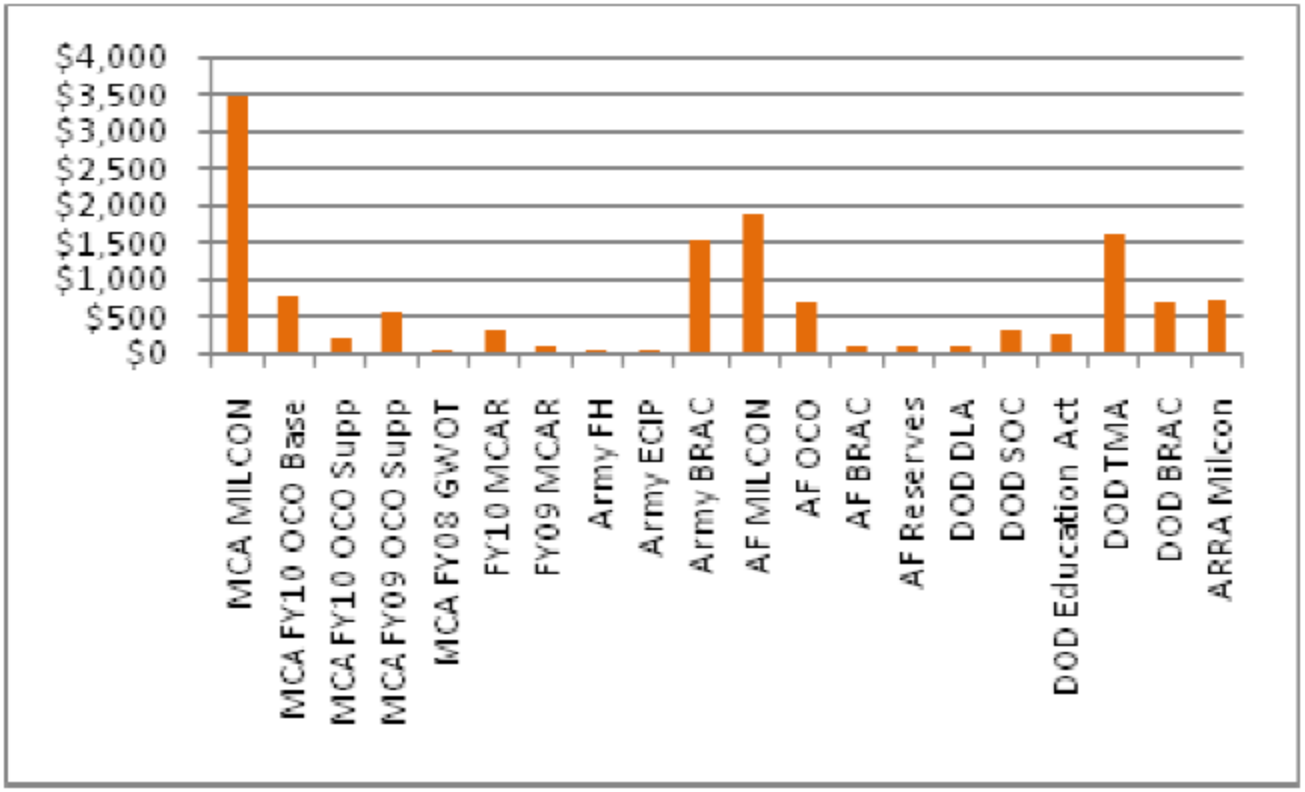
Utility Energy Methods

Water Consumption Associated with Purchased Electricity and Steam

- Water Bootprint study considers water consumed in the generation of electricity that is produced off-post and purchased by the Army
- Water consumption associated with electricity or steam generated on-post has been captured elsewhere, and is not accounted for in this study
- Data collected to support initial reporting of Greenhouse Gas (GHG) Inventory (pursuant to EO 13514) can be leveraged to support this study (e.g., installation energy consumption data from the Energy Management Data Report)
- Water consumption estimates will be generated by multiplying energy purchased by water consumption factors derived from scientific literature, which consider:
  - Mining, extraction, beneficiation, production, and transportation of raw fuels used to generate electricity and steam
  - Water consumed while producing electricity (e.g., cooling water, make-up water, flue gas desulfurization)
- Water consumption estimates will be compared with other modeling techniques

Army End Users

MILCON



Source: **U.S. ARMY CORPS OF ENGINEERS – DIRECTORATE OF MILITARY PROGRAMS**
441 G STREET NW; WASHINGTON, DC 20314
http://usace.army.mil/CEMP/Pages/Home.aspx

Interagency & International Support Bootprint Calculation Steps

- Obtain from HQ, USACE total amount spent in FY10 on I&IS construction and other services
- Align various construction categories to appropriate Eco-LCA model economic market sectors
- Adjust expenditures to 1997 economy using CPI factors
- Multiply adjusted expenditures in each construction category by applicable water use factor/$1M to determine total water bootprint

Army End Users

Interagency & International Support Bootprint Calculation

IIS Program Component	FY10 Funded ($M)	CPI Conversion Factor[a]	FY10 Funded ($M) (Adjusted)	Water Use (L/$1M)	Water Use (Gal/$1M)	Total Water Use (Gal)
Interagency Support[b]	$ 2,014	0.74	$1,490	18,378,103	4,854,981	7,233,921,690
International Support, Europe, South America, Pacific, and Middle East[b]	$ 7,006	0.74	$5,184	18,378,103	4,854,981	25,168,221,504
International Support, Foreign Military Sales[b]	$ 940	0.74	$ 696	18,378,103	4,854,981	3,379,066,776
Cooperative Threat Reduction[b]	$ 59	0.74	$ 44	18,378,103	4,854,981	213,619,164
Civil-Military Emergency Preparedness[c]	$ 2	0.74	$ 1.5	20,769,003	5,486,590	8,229,885
TOTALS	**$10,021**	**N/A**	**$7,416**	**N/A**	**N/A**	**36,003,059,019**
Water Footprint (Gal)	**36,003,059,019**	Or 54,550,089 Olympic Sized Swimming pools worth of water				

Notes:
a: =161.3/218.1
b: Model sector = Other Construction
c: Model sector = Social Assistance

Class III Methods

- Water Bootprint study considers water consumed in the production and transportation of bulk fuels purchased by the Army
- Water consumption associated with use of the fuel to generate steam, heat, or electricity or in aircraft, vehicles, and equipment is not captured
- Fuels include: coal, oil, natural gas, gasoline, diesel, aviation gas, jet fuel, and biofuels (e.g., ethanol, biodiesel, and biomass)
- Data collected to support initial reporting of GHG Inventory (pursuant to EO 13514) can be leveraged to support this study (e.g., FAST fuel consumption data and other non-fleet fuel consumption data from DLA purchases)
- Water consumption estimates will be generated by multiplying fuel quantities by water consumption factors derived from scientific literature, which consider:
    - Mining, extraction, beneficiation, production, and transportation of fuels
- Water consumption estimates will be compared with other modeling techniques

Supply Classes
Bootprint Calculation Steps

- Class III – Fuels
  - Obtain fuel consumption data by type from FY10 Army GHG inventory
  - For each fuel type, apply known water use factor (e.g., 3-7 gallons of water per gallon of gasoline) to total quantity purchased
- All other supply classes
  - Obtain annual aggregate purchase data for various product categories from appropriate source(s) (e.g., AAFES provided CY10 Class VI gross sales data in 4 categories – gasoline, retail less gasoline, food & beverages, concessions)
  - Adjust sales data to 1997 economy using CPI conversion factors
  - Align annual purchases to appropriate Eco-LCA model sector(s)
  - Apply model to estimate aggregate water bootprint

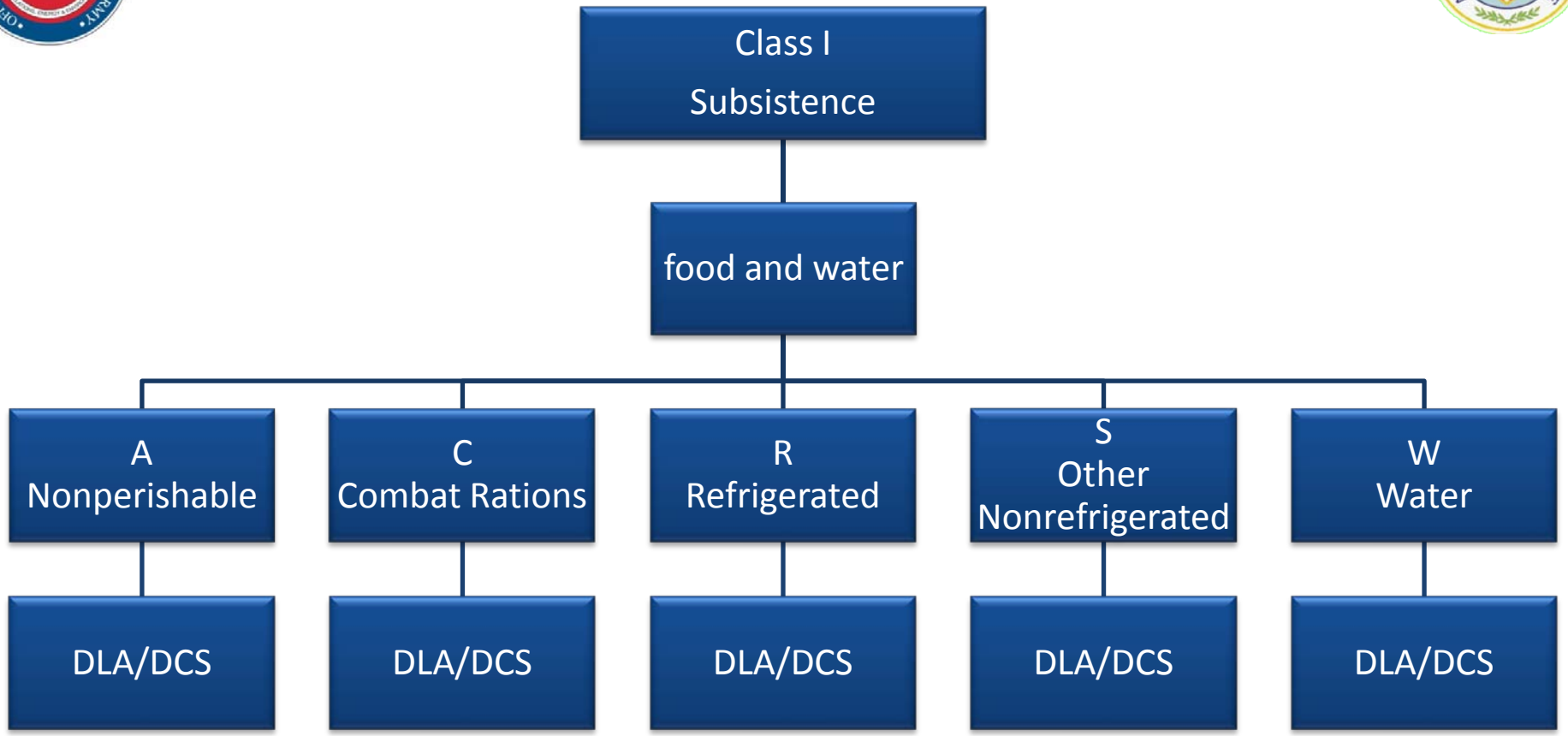
NSN Nomenclature

- Federal Supply Group or FSG Code is the 1st 2 digits of the Federal Supply Class (FSC)
- FSC Code is a 4 digit general description assigned based on end use
- National Item Identification Number or NIIN is a 9 digit number that when combined with the FSC code provide the National Stock Number (NSN)
- The FSC plus the NIIN = NSN (National Stock Number)

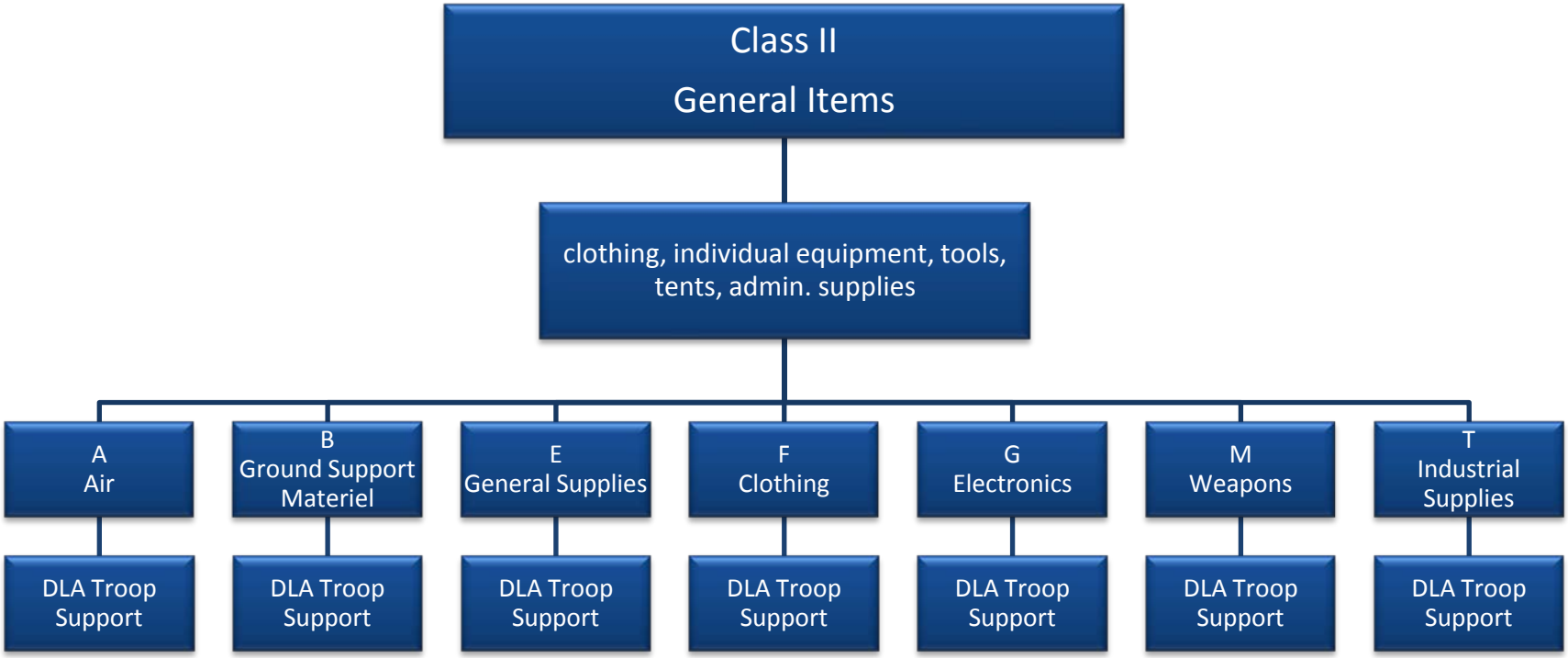
FSC NIIN
6645-00-123-4567 = NSN

Analytical Approach

- DoD identifies material into 10 classes of supply. The class of supply did not provide enough detail to match model market sector coefficients from ECO-LCA
- First identified the current list of Federal Supply Group (FSG) which represents the 1st 2 digits of the Federal Supply Code (FSC). There are approximately 80 FSGs.
- Still not enough level of detail in the FSG description so went to the FSC level which is the 1st 4 digits of the NSN. There are approximately 650 FSCs.
- Best fit matches for all FSCs except 40. Matches could not be determined because:
  - The FSC description was too general and the ECO-LCA model market sector was specific down to type of material used for the items (e.g. wood vs. metal vs. plastic etc.)
  - The FSC descriptor was too general and needed additional information to make a match
- Determined that there was a need to go down to the NIIN (last 9 digits of an NSN) level to determine ECO-LCA model market sector fits for those 40 FSCs
- Obtained Army wholesale procurement data from LMARS (Logistics Metrics Analysis Reporting System) from FYs 2002 – 2010, and matched actual NIIN level data for the 40 FSCs
- By applying the actual LMARS NIIN data from FYs 2002 – 2010, it expanded the number of variables for the 40 FSCs to over 65,000 records
- Determined best fit matches from ECO-LCA based on NIIN level descriptions. For those FSC/NIIN combinations where the level of detail was still not sufficient to make a clear determination for a model market sector, “Wholesale trade” model market sector was used as a default



Supply Chain



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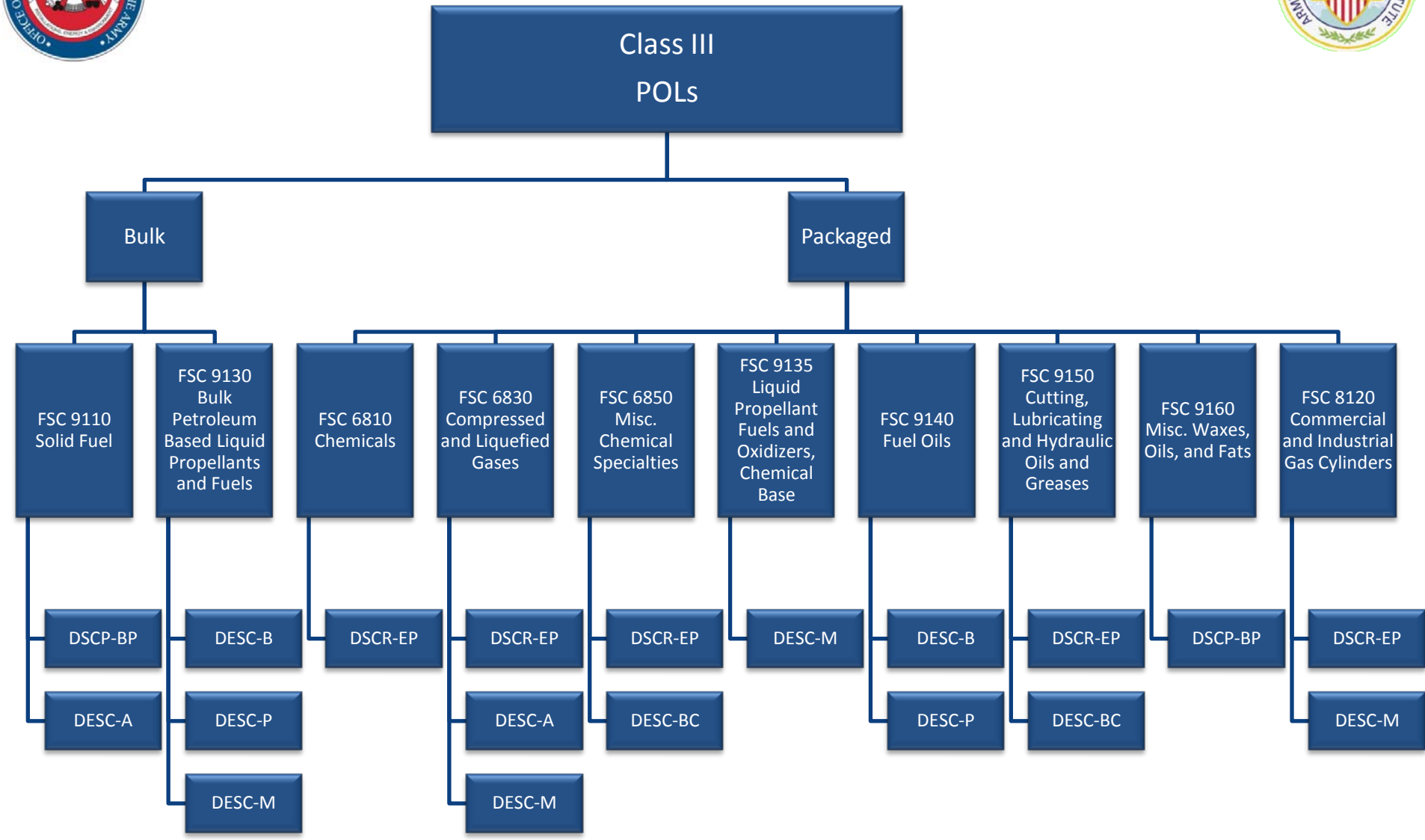

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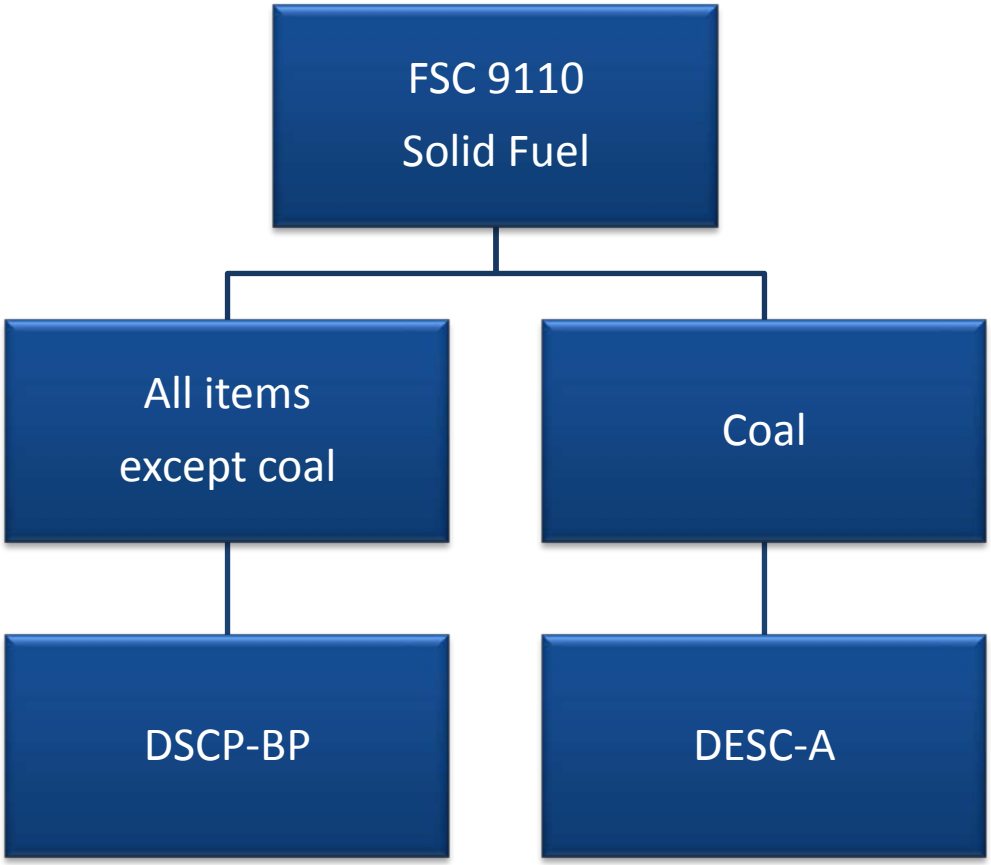
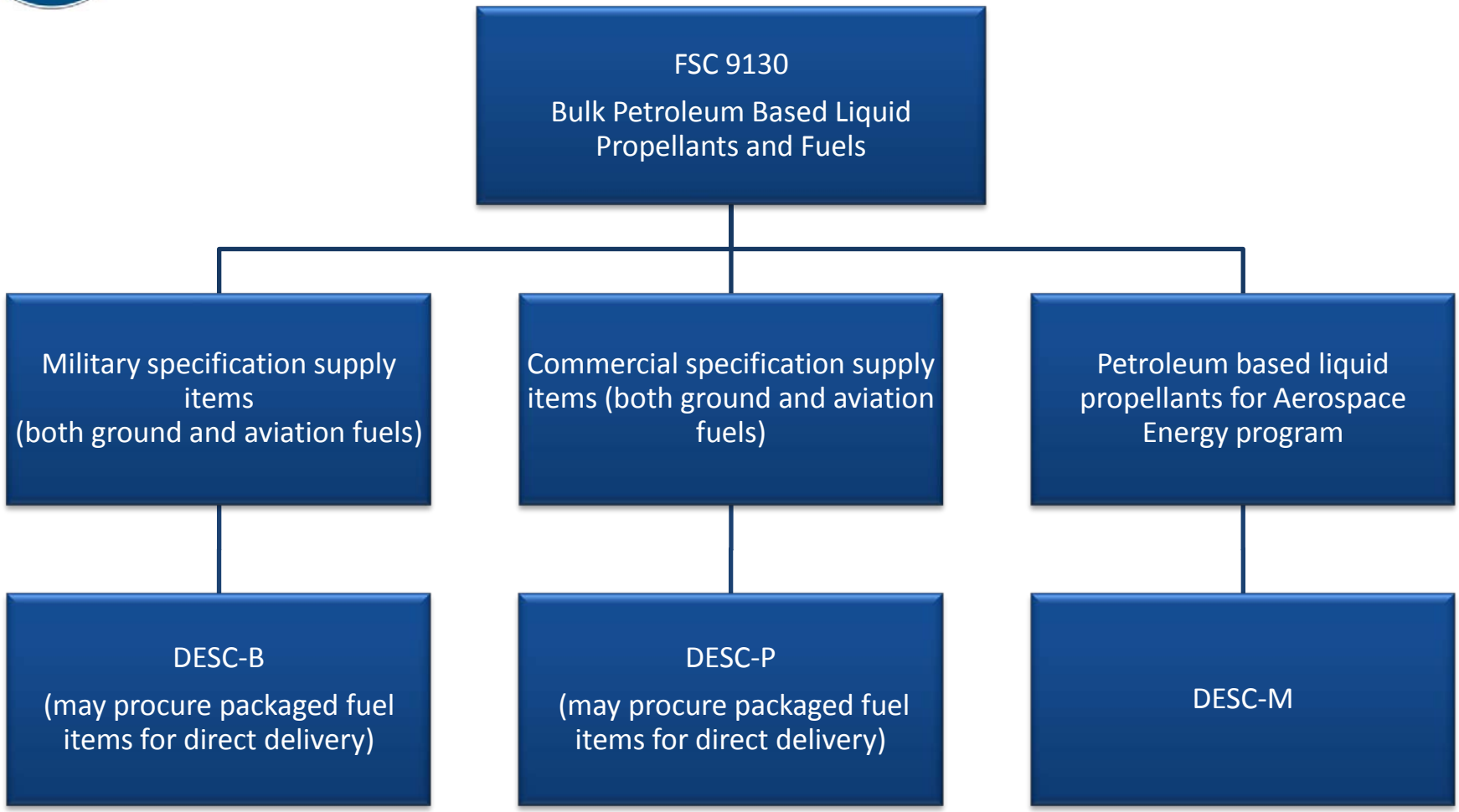
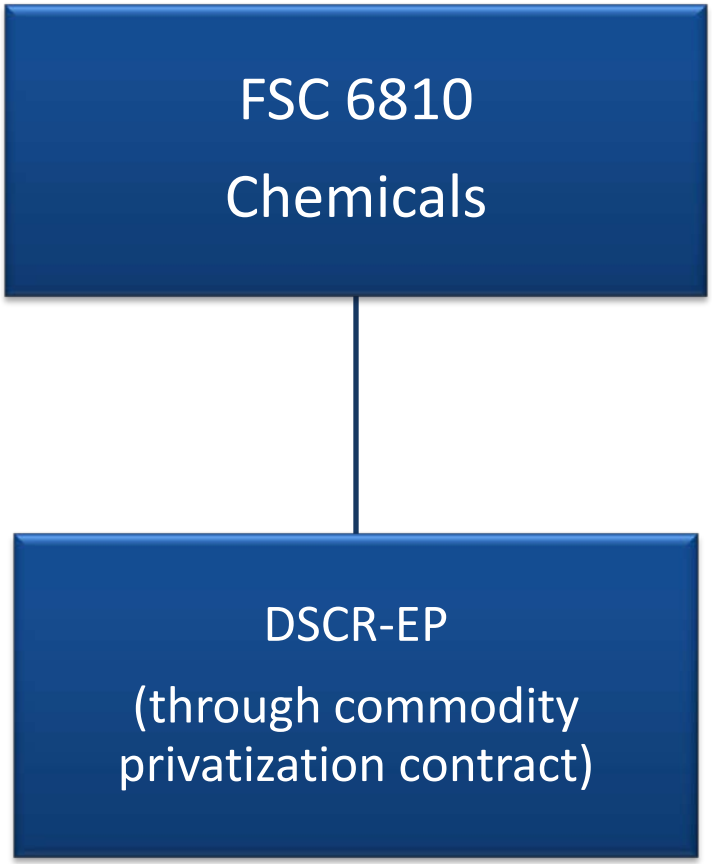
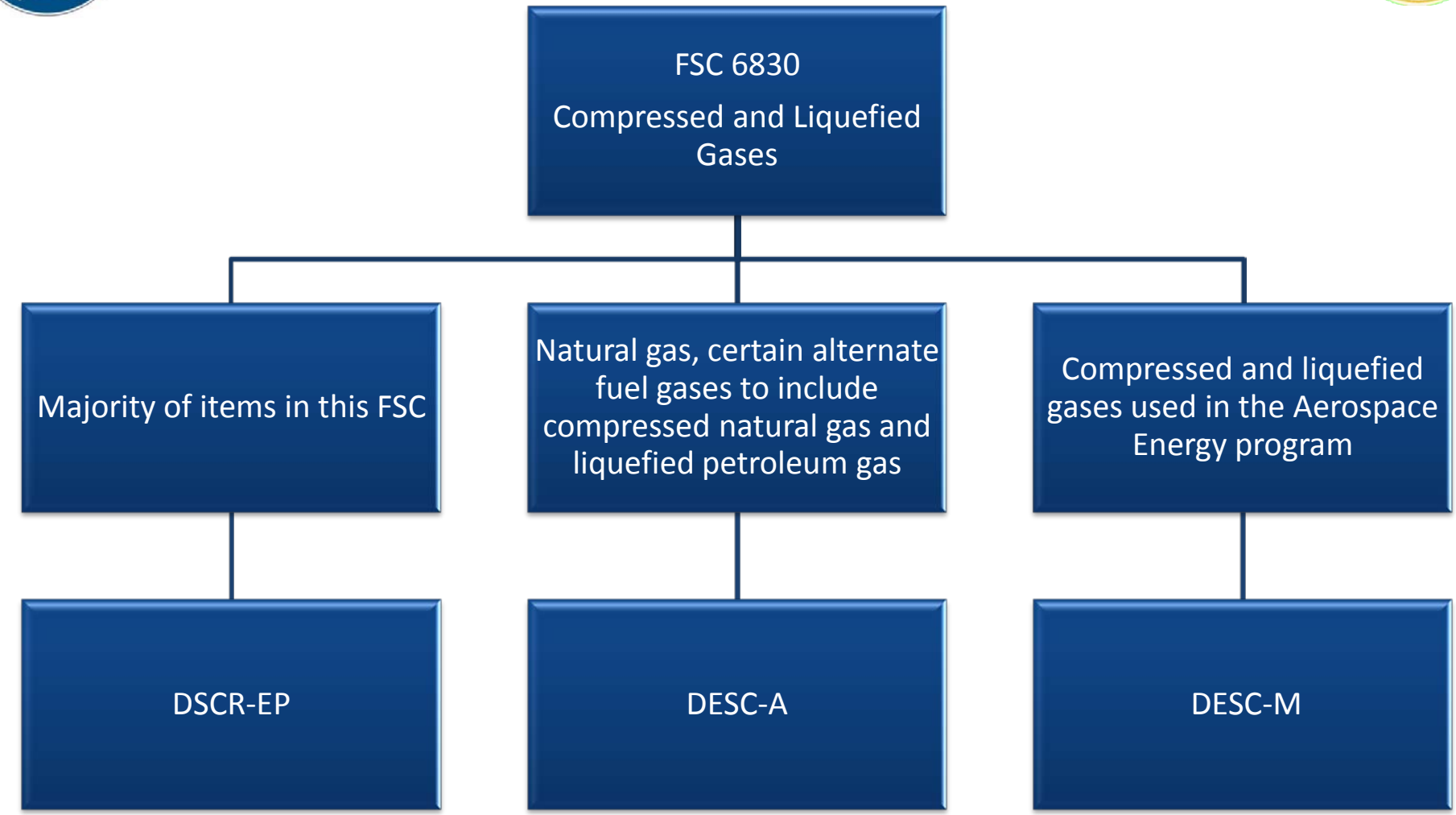


Class III

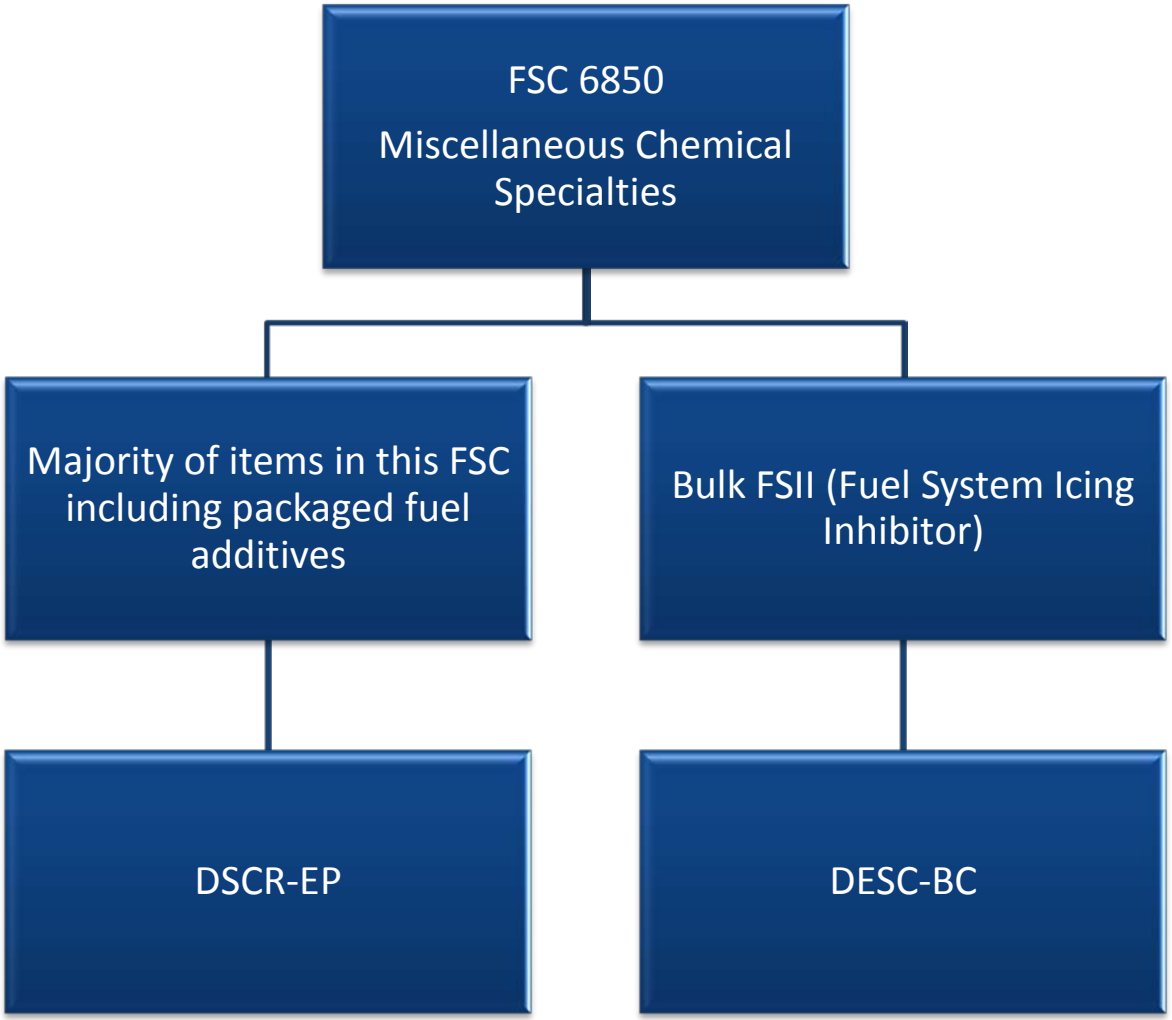

FSC 9130
Bulk Petroleum Based Liquid Propellants and Fuels
Military specification supply items (both ground and aviation fuels)
Commercial specification supply items (both ground and aviation fuels)
Petroleum based liquid propellants for Aerospace Energy program
DESC-B
(may procure packaged fuel items for direct delivery)
DESC-P
(may procure packaged fuel items for direct delivery)
DESC-M


FSC 6810
Chemicals
DSCR-EP
(through commodity privatization contract)

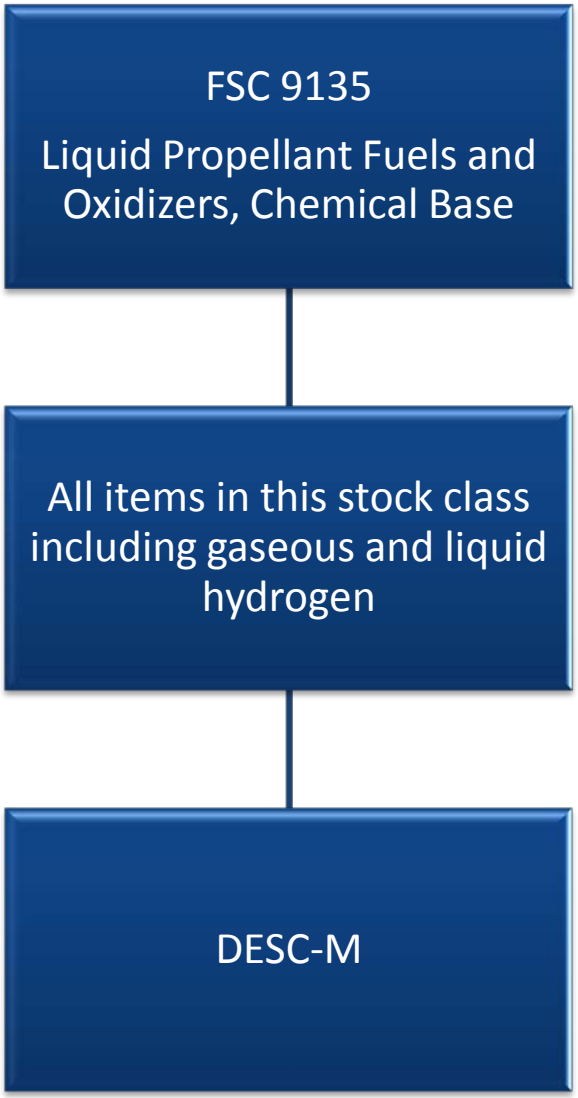
Class III


FSC 6830
Compressed and Liquefied Gases
Majority of items in this FSC
Natural gas, certain alternate fuel gases to include compressed natural gas and liquefied petroleum gas
Compressed and liquefied gases used in the Aerospace Energy program
DSCR-EP
DESC-A
DESC-M

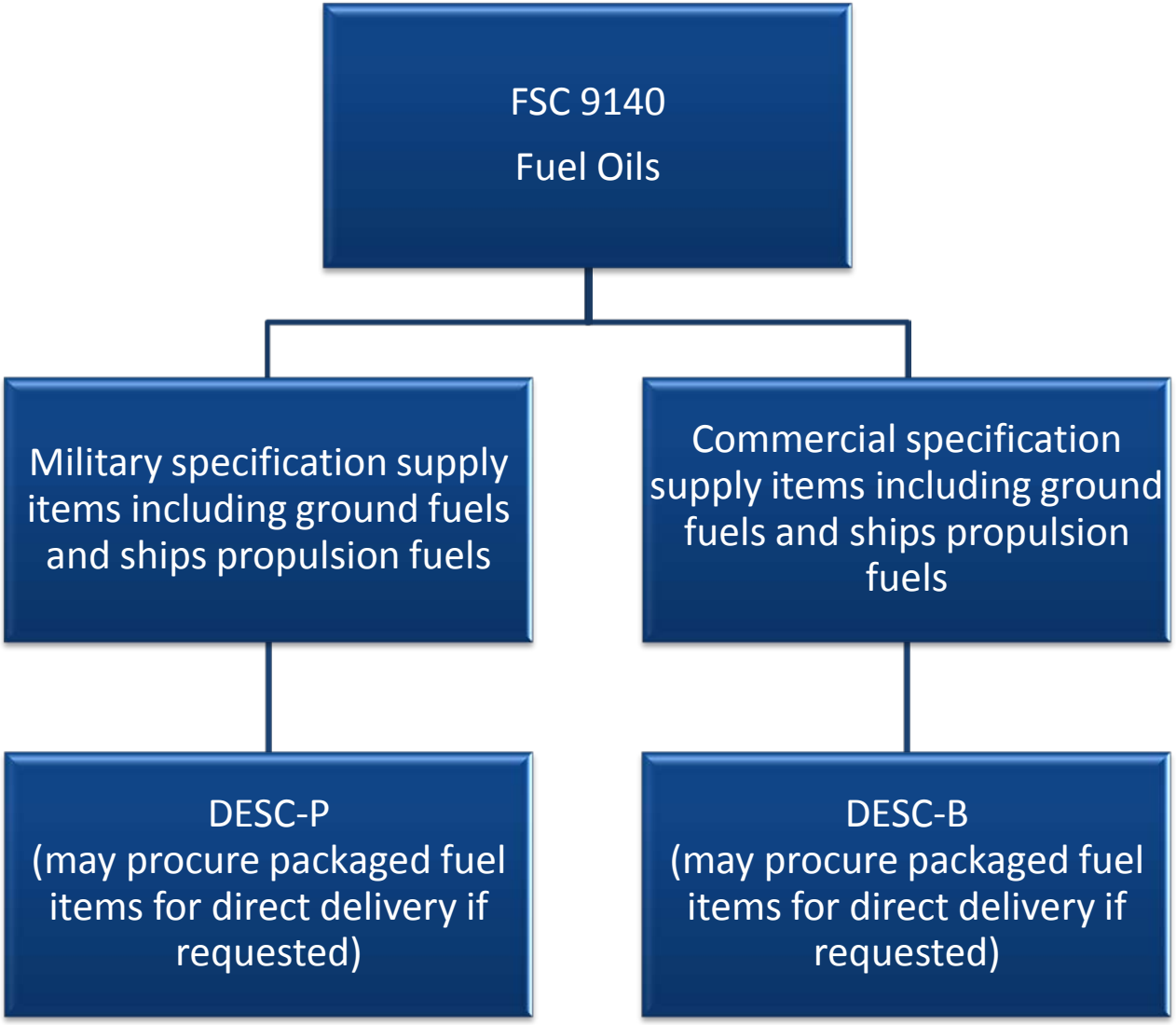
Class III


FSC 6850
Miscellaneous Chemical Specialties
Majority of items in this FSC including packaged fuel additives
Bulk FSII (Fuel System Icing Inhibitor)
DSCR-EP
DESC-BC

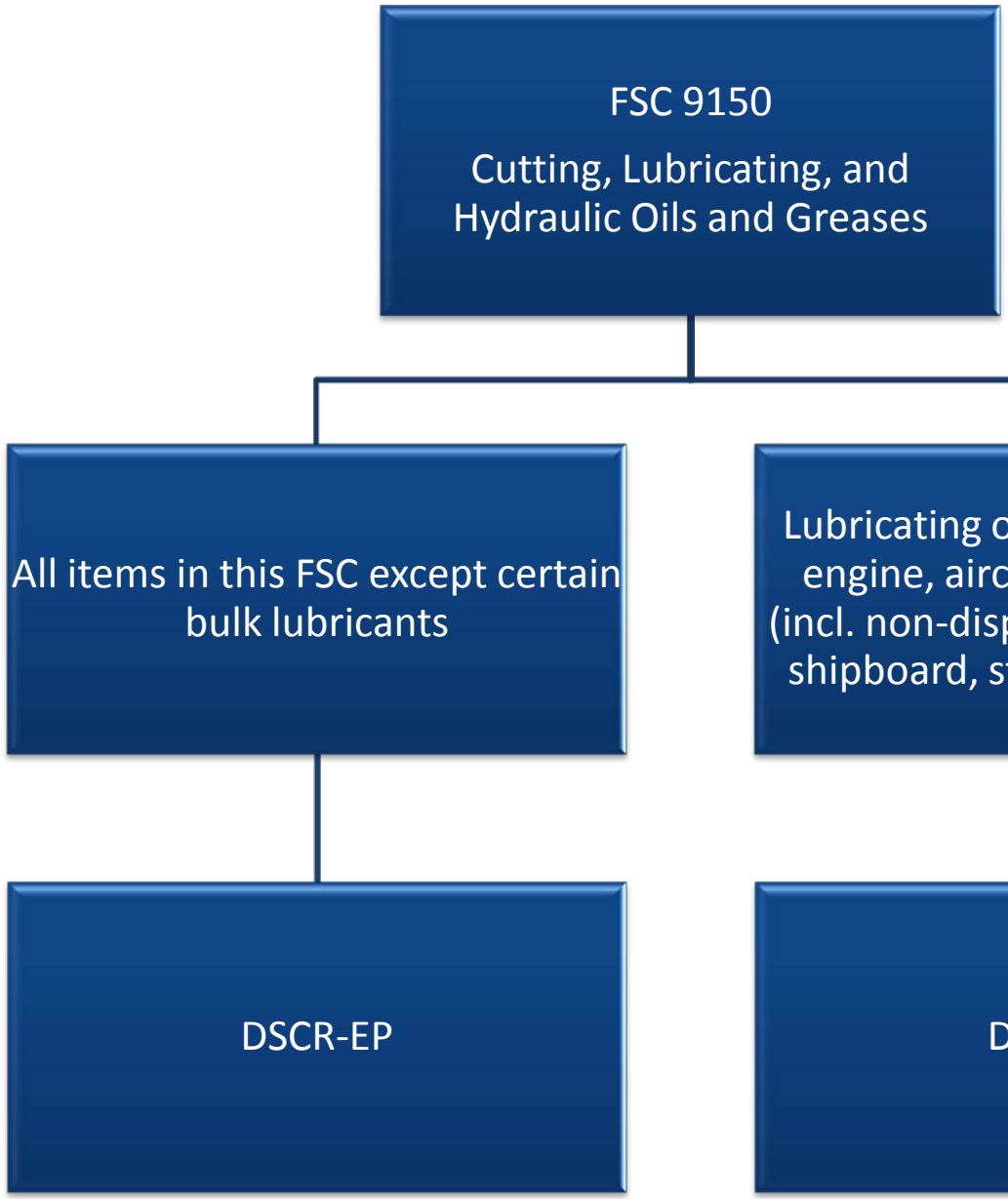
Class III


FSC 9135
Liquid Propellant Fuels and Oxidizers, Chemical Base
All items in this stock class including gaseous and liquid hydrogen
DESC-M

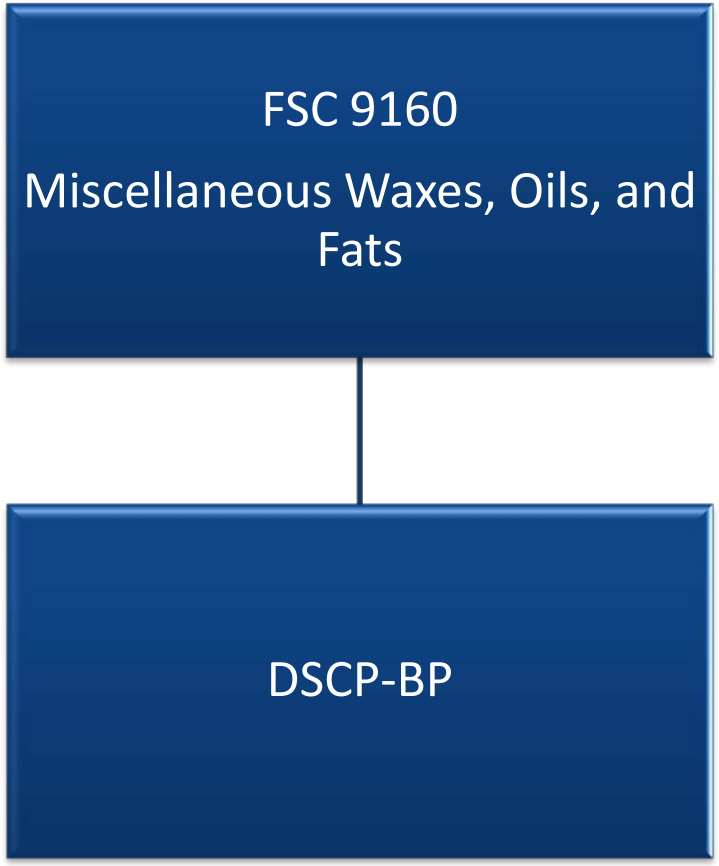
Class III


FSC 9140
Fuel Oils
Military specification supply items including ground fuels and ships propulsion fuels
Commercial specification supply items including ground fuels and ships propulsion fuels
DESC-P
(may procure packaged fuel items for direct delivery if requested)
DESC-B
(may procure packaged fuel items for direct delivery if requested)

Class III


FSC 9150
Cutting, Lubricating, and Hydraulic Oils and Greases
All items in this FSC except certain bulk lubricants
Lubricating oils: aircraft turbine engine, aircraft piston engine (incl. non-dispersant mineral oil), shipboard, steam turbine, gear
DSCR-EP
DESC-BC

Class III



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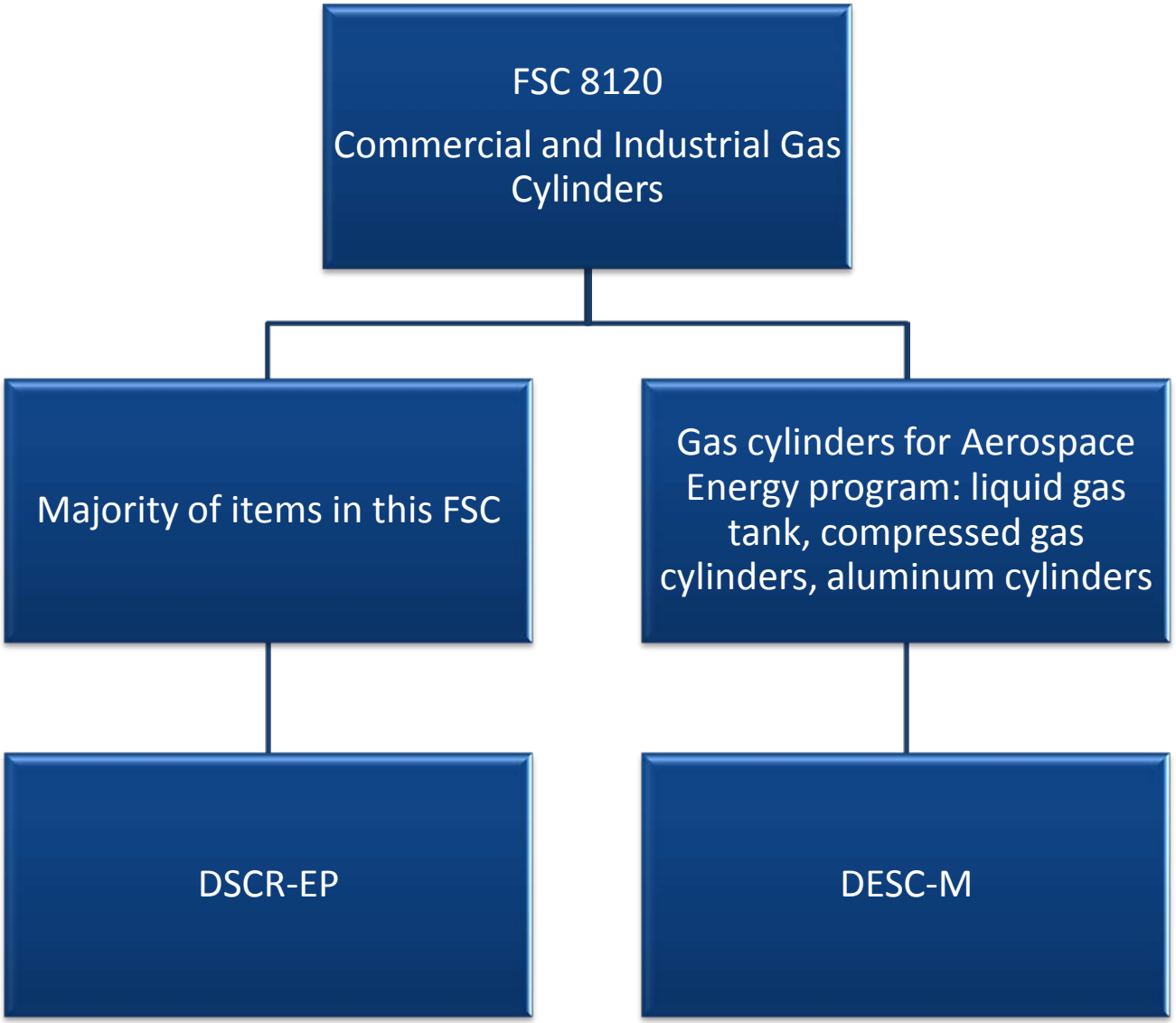
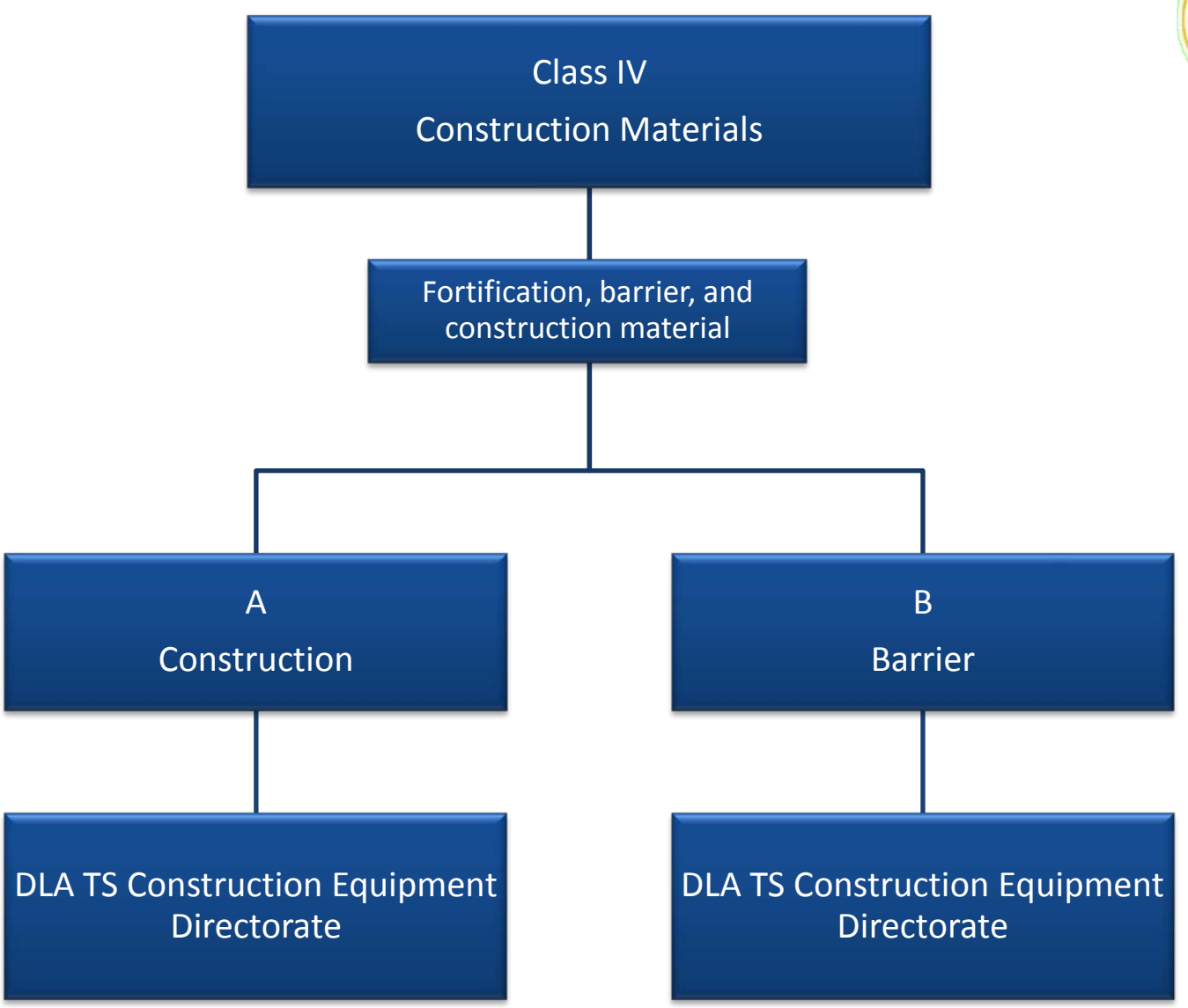
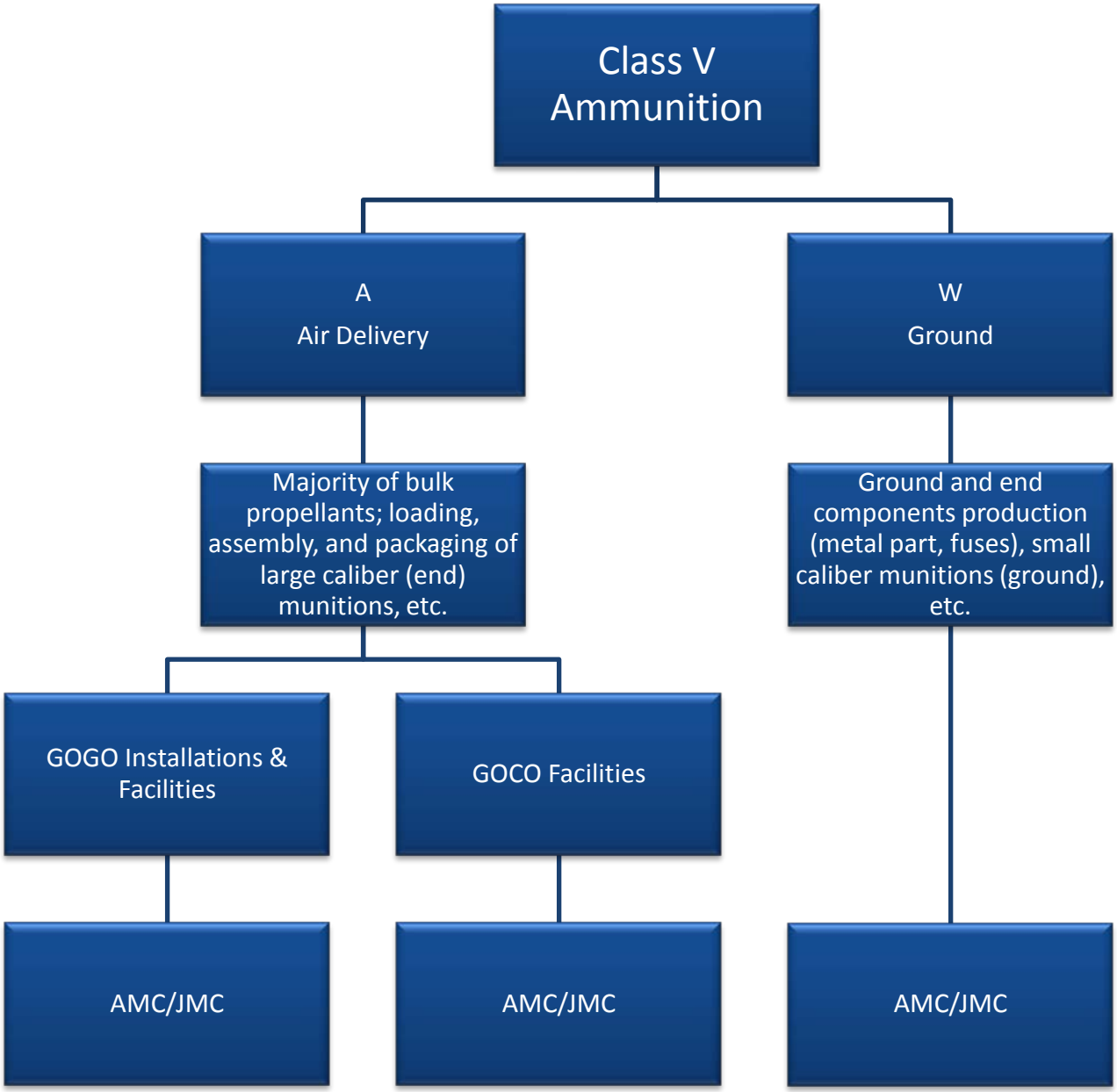

FSC 8120
Commercial and Industrial Gas Cylinders
Majority of items in this FSC
Gas cylinders for Aerospace Energy program: liquid gas tank, compressed gas cylinders, aluminum cylinders
DSCR-EP
DESC-M

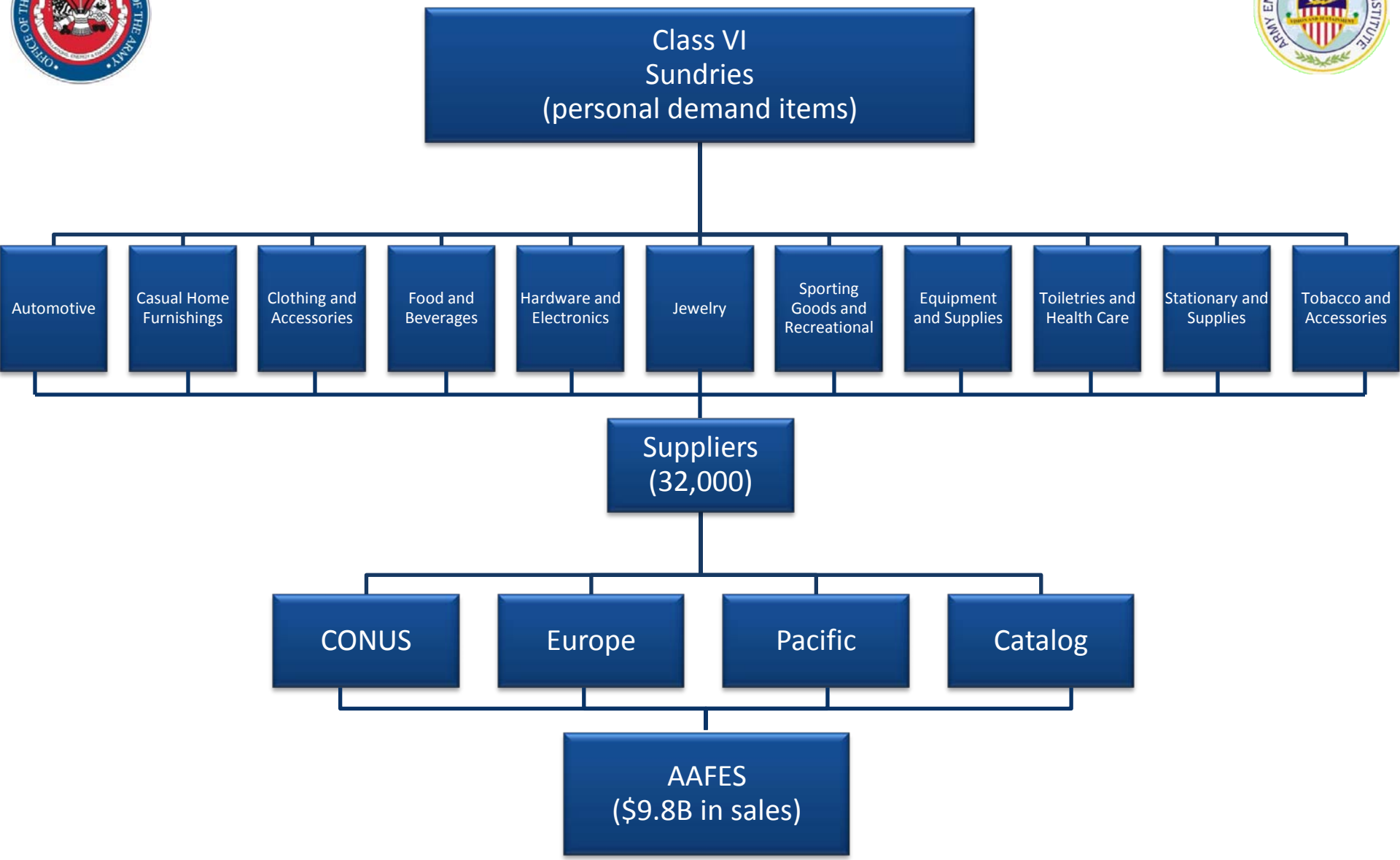
Class III



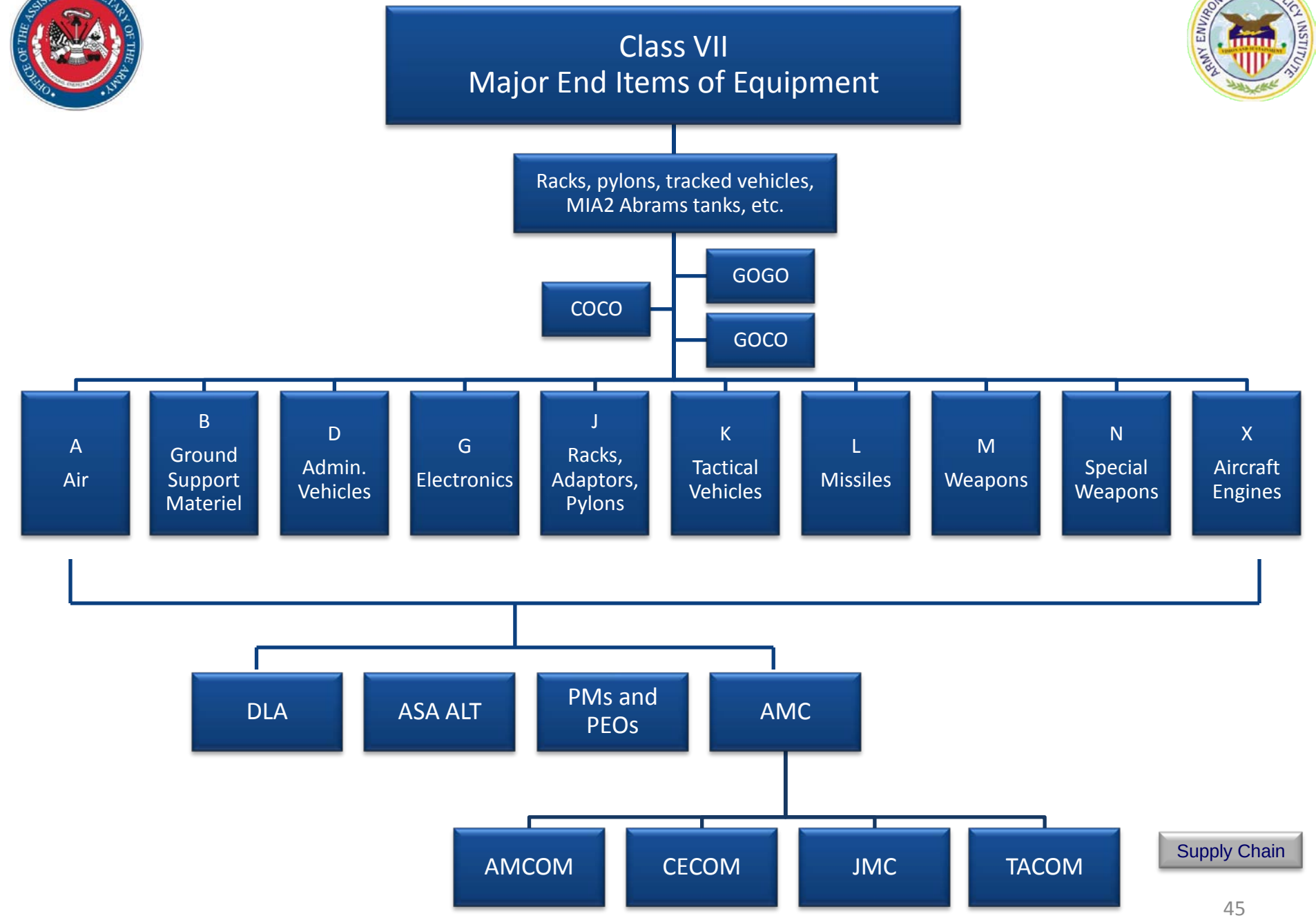
Supply Chain

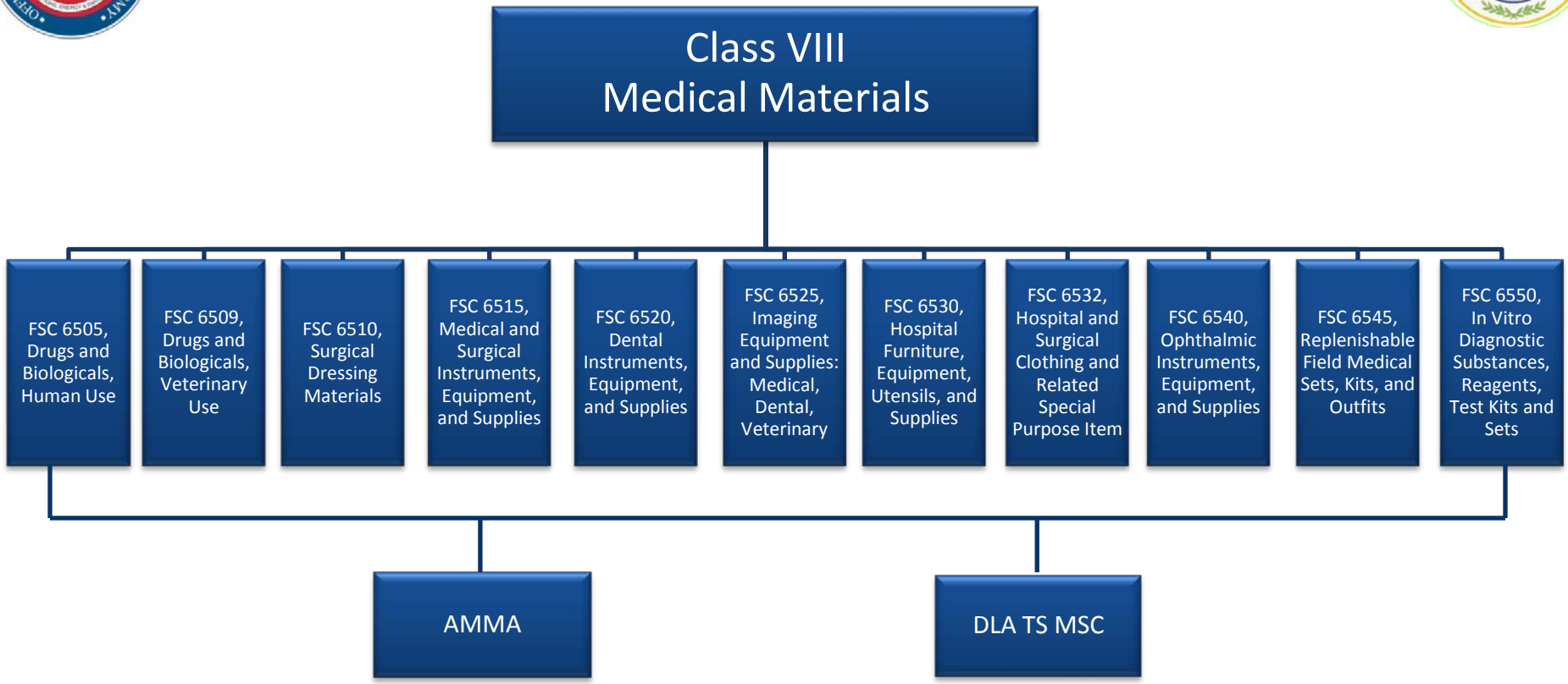


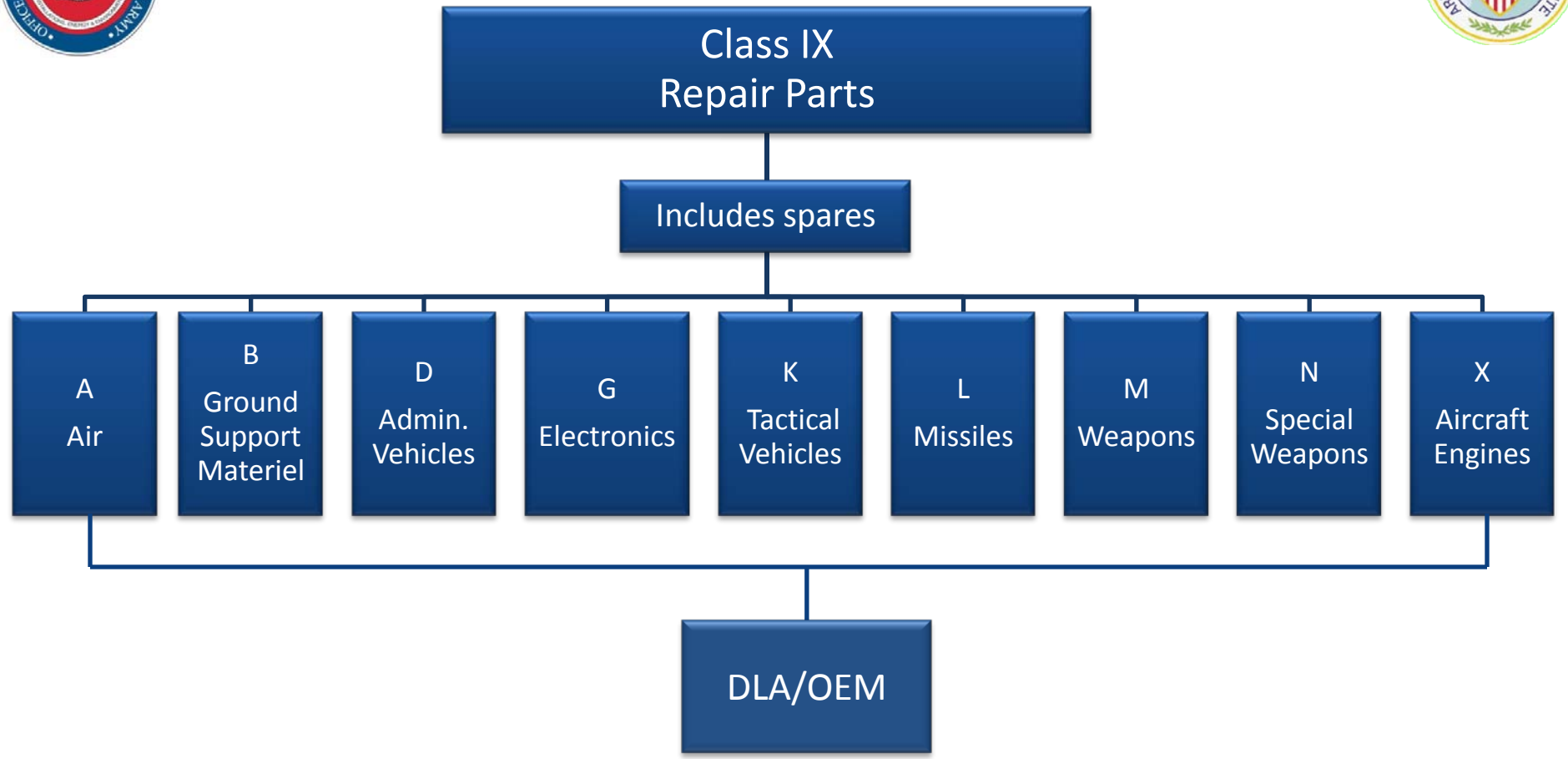
Supply Chain



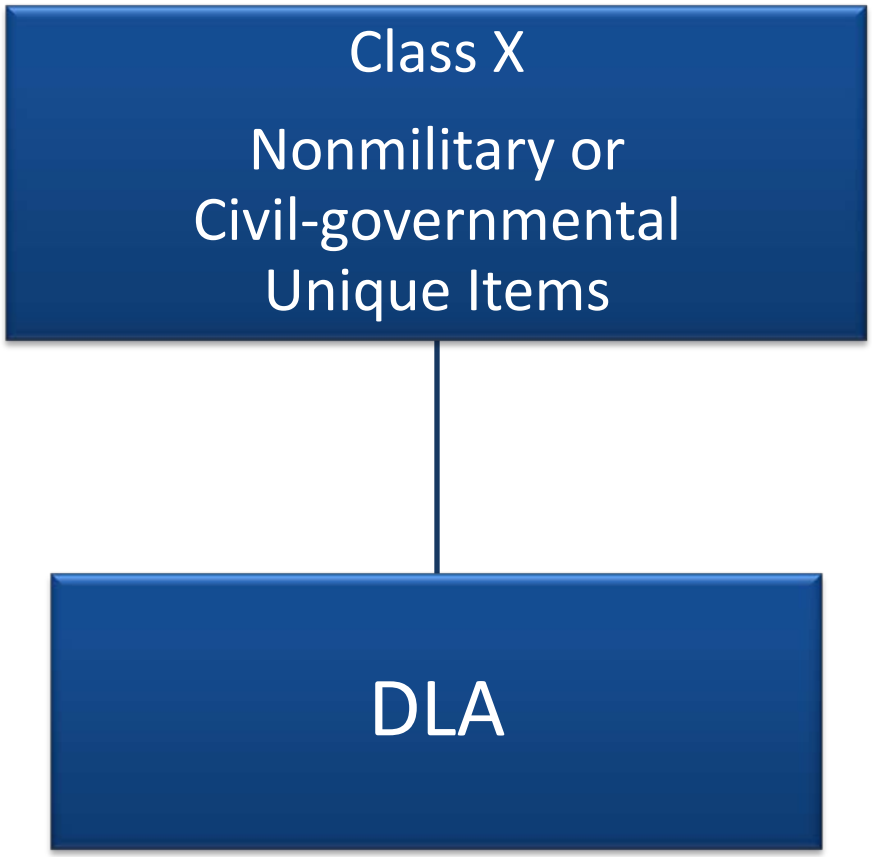
Supply Chain

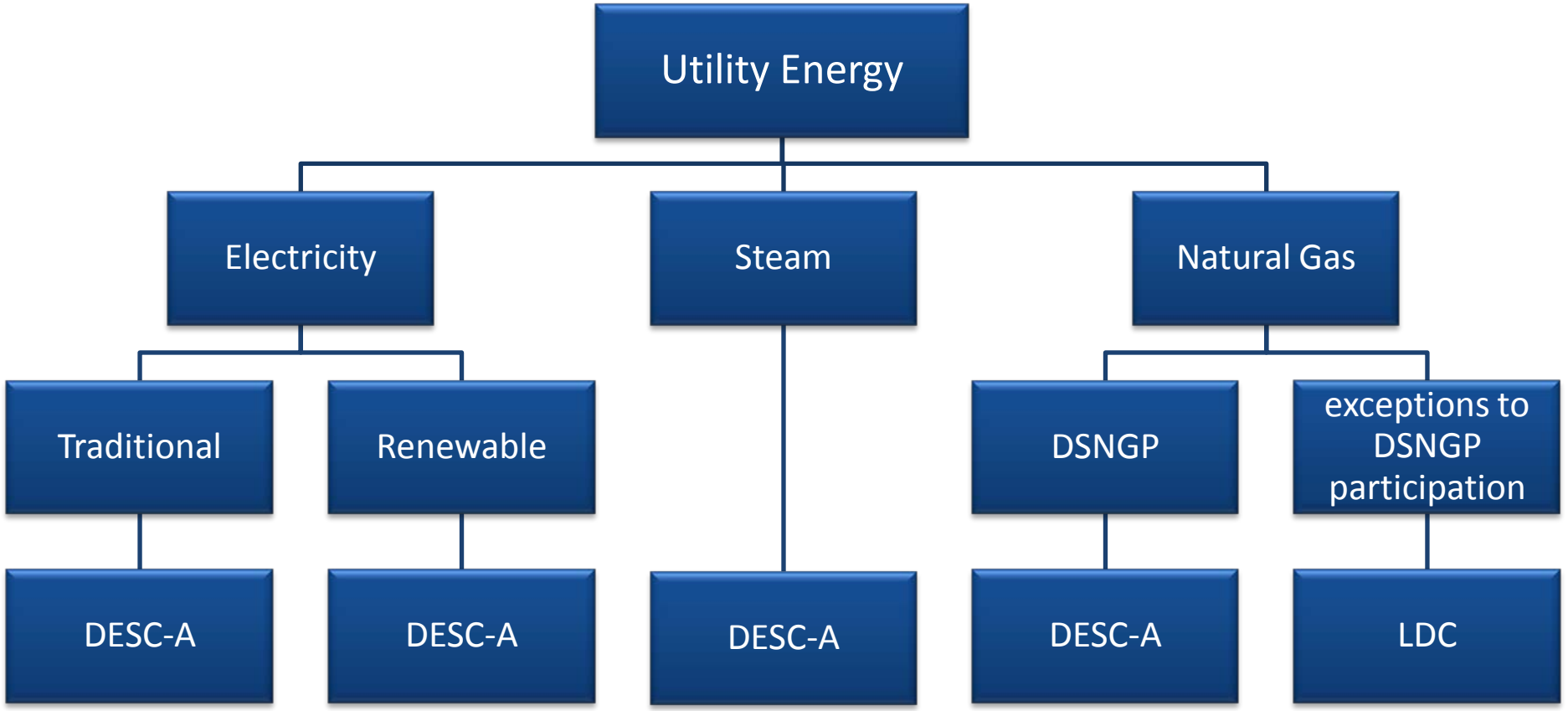

Class VII
Major End Items of Equipment
Racks, pylons, tracked vehicles, MIA2 Abrams tanks, etc.
COCO
GOGO
GOCO
A Air
B Ground Support Materiel
D Admin. Vehicles
G Electronics
J Racks, Adaptors, Pylons
K Tactical Vehicles
L Missiles
M Weapons
N Special Weapons
X Aircraft Engines
DLA
ASA ALT
PMs and PEOs
AMC
AMCOM
CECOM
JMC
TACOM
Supply Chain


Class VIII
Medical Materials
FSC 6505, Drugs and Biologicals, Human Use
FSC 6509, Drugs and Biologicals, Veterinary Use
FSC 6510, Surgical Dressing Materials
FSC 6515, Medical and Surgical Instruments, Equipment, and Supplies
FSC 6520, Dental Instruments, Equipment, and Supplies
FSC 6525, Imaging Equipment and Supplies: Medical, Dental, Veterinary
FSC 6530, Hospital Furniture, Equipment, Utensils, and Supplies
FSC 6532, Hospital and Surgical Clothing and Related Special Purpose Item
FSC 6540, Ophthalmic Instruments, Equipment, and Supplies
FSC 6545, Replenishable Field Medical Sets, Kits, and Outfits
FSC 6550, In Vitro Diagnostic Substances, Reagents, Test Kits and Sets
AMMA
DLA TS MSC

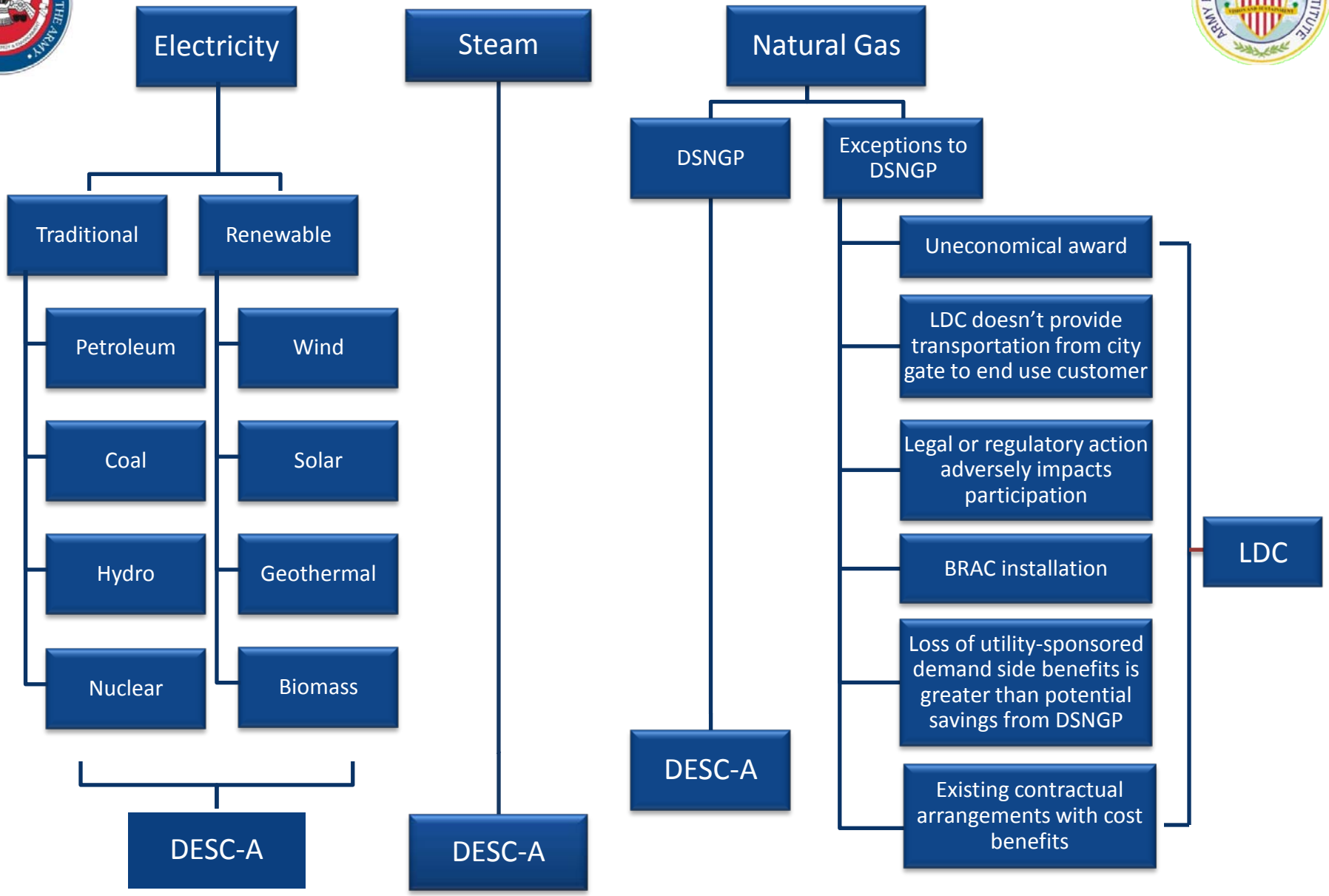


Supply Chain


Class X
Nonmilitary or
Civil-governmental
Unique Items
DLA



Army End Users


Electricity
Traditional
Renewable
Petroleum
Coal
Hydro
Nuclear
Wind
Solar
Geothermal
Biomass
DESC-A
Steam
DESC-A
Natural Gas
DSNGP
Exceptions to DSNGP
DESC-A
Uneconomical award
LDC doesn't provide transportation from city gate to end use customer
Legal or regulatory action adversely impacts participation
BRAC installation
Loss of utility-sponsored demand side benefits is greater than potential savings from DSNGP
Existing contractual arrangements with cost benefits
LDC

Interagency Support

Supported Department or Agency	FY10 Funded ($M)
Department of State	$630.0
Department of Veterans Affairs	$348.7
Environmental Protection Agency	$308.2
Department of Homeland Security, Customs & Border Protection	$254.2
Department of Homeland Security, FEMA	$86.1
Department of Interior	$55.6
Department of Energy	$51.0
National Aeronautics and Space Administration	$28.1
Department of Justice	$17.7
Department of Homeland Security, Other	$16.6
Department of Commerce	$16.3
Agency for International Development	$13.0
Capitol Building, Architect of the Capitol	$12.6
Department of Health and Human Services	$11.8
Department of Agriculture	$10.7
Department of Transportation	$9.4
Government Corporations and Commissions	$8.6
Arlington National Cemetery	$5.4
National Science Foundation	$4.2
General Services Administration	$2.1
Department of Housing and Urban Development	$1.3
Office of Personnel Management	$1.2
Other Federal Agencies	$2.5
State, Local, Tribal, and Private Sector	$118.6
TOTAL	**$2,013.9**

Source: HQ, USACE;usace.army.mil/cemp/iis/FY10 summary for ASA(CW).xls.